

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Four times amended) A method for [establishing cryptographic] communications of a message cryptographically processed with RSA (Rivest, Shamir & Adleman) public key encryption, comprising the [step] steps of:

developing k distinct random prime numbers p_1, p_2, \dots, p_k , wherein k is an integer greater than 2;

providing a number e relatively prime to $(p_1-1) \cdot (p_2-1) \cdot \dots \cdot (p_k-1)$;

providing a composite number n equaling the product $p_1 \cdot p_2 \cdot \dots \cdot p_k$;

receiving a ciphertext word signal C which is formed by encoding a plaintext message word signal M to a ciphertext word signal C, where M corresponds to a number representative of [a] the message and

$$0 \leq M \leq n-1$$

[n being a composite number formed from the product of $p_1 \cdot p_2 \cdot \dots \cdot p_k$ where k is an integer greater than 2, p_1, p_2, \dots, p_k are distinct prime numbers, and] where C is a number representative of an encoded form of the plaintext message word signal M such that

$$C \equiv M^e \pmod{n}$$

and where e is associated with an intended recipient of the ciphertext word signal C; and [, wherein said encoding step comprises the step of: transforming said message word signal M to said ciphertext word signal C whereby

$$C = M^e \pmod{n}$$

where e is a number relatively prime to $(p_1-1) \cdot (p_2-1) \dots (p_k-1)$
deciphering the received ciphertext word signal C at the intended recipient
having available to it the k distinct random prime numbers p_1, p_2, \dots, p_k ;
wherein p and q are a pair of prime numbers that product of which equals a
composite number m , the k distinct random prime numbers each smaller
than p and q , and the composite number m having the same number of
digits as the composite number n ;
wherein the deciphering step is divided into sub-steps, one sub-step for each
of the k distinct random prime numbers; and
wherein for a given number of digits for composite numbers n and m , it takes
fewer computational cycles to perform the deciphering step if the k
distinct random prime numbers are used, relative to the number of
computational cycles for performing a deciphering step if the pair of prime
numbers p and q is used instead.

2. (Twice amended) The method according to claim 1, [comprising the further step of:] wherein the deciphering step includes
establishing a number, d , as a multiplicative inverse of $e(\text{mod}(\text{lcm}((p_1-1),$
 $(p_2-1), \dots, (p_k-1))))$, and
decoding the ciphertext word signal C to the plaintext message word signal
 M , wherein said decoding step comprises the step of: transforming said
ciphertext word signal C ,] where [by: $M = C^d \pmod{n}$] $M \equiv C^d \pmod{n}$.
[where d is a multiplicative inverse of $e(\text{mod}(\text{lcm}((p_1-1), (p_2-1), \dots, (p_k-1))))$.]

3. (Four times amended) A method for [transferring a message signal M_i in a] communications of a message signal M_i cryptographically processed with
RSA public key encryption in a system having j terminals, [wherein] each
terminal [is] being characterized by an encoding key $E_i = (e_i, n_i)$ and a decoding
key $D_i = (d_i, n_i)$, where $i = 1, 2, \dots, j$, and [wherein] the message signal M_i

corresponds to a number representative of a message-to-be-received
[transmitted] from the i^{th} terminal, the method comprising the steps of:
establishing n_i where n_i is a composite number of the form

$$[n_i = p_{i,1} \cdot p_{i,2} \cdot \dots \cdot p_{i,k}] \quad \underline{n_i = p_{i,1} \cdot p_{i,2} \cdot \dots \cdot p_{i,k}}$$

where k is an integer greater than 2,

$p_{i,1}, p_{i,2}, \dots, p_{i,k}$ are distinct random prime numbers,

e_i is relatively prime to $[\text{lcm}(p_{i,1}-1, p_{i,2}-1, \dots, p_{i,k}-1)]$ $\text{lcm}(p_{i,1}-1, p_{i,2}-1, \dots,$
 $p_{i,k}-1)$, and

d_i is selected from the group consisting of [the] a class of numbers
equivalent to a multiplicative inverse of

$$e_i(\text{mod}(\text{lcm}((p_{i,1}-1), (p_{i,2}-1), \dots, (p_{i,k}-1))))[.];$$

[comprising the step of:]

receiving by a recipient terminal ($i = y$) from a sender terminal ($i = x, x \neq y$) a
ciphertext signal C_x formed by encoding a digital message word signal
 M_x , wherein the encoding includes $[M_A$ for transmission from a first
terminal ($i=A$) to a second terminal ($i=B$), said encoding step including the
sub-step of:]

transforming said message word signal M_A to one or more message
block word signals $[M_A"] \underline{M_x"}$, each block word signal $[M_A"] \underline{M_x"}$
corresponding to a number representative of a portion of said
message word signal $[M_A] \underline{M_x}$ in the range $0 \leq M_x" \leq n_y-1$ [$0 \leq M_A"$
 $\leq n_B-1$], and

transforming each of said message block word signals $[M_A"] \underline{M_x"}$ to a
ciphertext word signal $[C_A, C_A \text{ corresponding}] \underline{C_x}$ that corresponds
to a number representative of an encoded form of said message
block word signal $[M_A"] \underline{M_x"}[.]$ where[by:]

$$[C_A \equiv M_A^{e_B} \pmod{n_B}] \quad \underline{C_x \equiv M_x^{e_y} \pmod{n_y}}; \text{ and}$$

deciphering the received ciphertext word signal C_x at the recipient terminal
having available to it the k distinct random prime numbers $p_{y,1}, p_{y,2}, \dots,$
 $p_{y,k}$ for establishing its d_y ;

wherein p and q are a pair of prime numbers that product of which equals a
composite number m , the k distinct random prime numbers each smaller
than p and q , and the composite number m having the same number of
digits as the composite number n ;

wherein the deciphering step is divided into sub-steps, one sub-step for each
of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m , it takes
fewer computational cycles to perform the deciphering step if the k
distinct random prime numbers are used, relative to the number of
computational cycles for performing a deciphering step if the pair of prime
numbers p and q is used instead.

4. (Five times amended) A [cryptographic communications] system for
communications of a message cryptographically processed with an RSA public
key encryption, comprising:

a communication [medium] channel for transmitting a ciphertext word signal
 C ;

[an] encoding means coupled to said channel and adapted for transforming
a transmit message word signal M to [a] the ciphertext word signal C
using a composite number, n ,

where n is a product of the form

$$\underline{n = p_1 \cdot p_2 \cdot \dots \cdot p_k,}$$

where k is an integer greater than 2, and p_1, p_2, \dots, p_k are distinct random prime numbers, [and for transmitting C on said channel,]

where the transmit message word signal M corresponds to a number representative of [a] the message and [] $0 \leq M \leq n-1$, [where n is a composite number of the form

$$n = p_1 \cdot p_2 \cdot \dots \cdot p_k$$

where k is an integer greater than 2 and p_1, p_2, \dots, p_k are distinct prime numbers, and] where the ciphertext word signal C corresponds to a number representative of an [enciphered] encoded form of said message through a relationship of the form [and corresponds to]

$$C \equiv M^e \pmod{n}, \text{ and}$$

where e is a number relatively prime to $\text{lcm}(p_1-1, p_2-1, \dots, p_k-1)$; and

[a] decoding means coupled to said channel and adapted for receiving the ciphertext word signal C from said channel and, having available to it the k distinct random prime numbers p_1, p_2, \dots, p_k , for transforming the ciphertext word signal C to a receive message word signal M' where M' corresponds to a number representative of a [deciphered] decoded form of the ciphertext word signal C [and corresponds to] through a relationship of the form

$$M' \equiv C^d \pmod{n}$$

where d is selected from the group consisting of [the] a class of numbers equivalent to a multiplicative inverse of

$$e(\text{mod}(\text{lcm}((p_1-1), (p_2-1), \dots, (p_k-1))))_i$$

wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime numbers each smaller than p and q, and the composite number m having the same number of digits as the composite number n;

wherein transforming the ciphertext word signal C to a receive message word signal M' is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m, it takes fewer computational cycles to perform the transforming of the ciphertext word signal C if the k distinct random prime numbers are used, relative to the number of computational cycles for performing a transforming of the ciphertext word signal C if the pair of prime numbers p and q is used instead.

5. (Four times amended) A [cryptographic communications] system for communications of a message cryptographically processed with an RSA public key encryption, the system having a plurality of terminals coupled by a communications channel, [including] comprising:

a first terminal of the plurality of terminals characterized by an [associated] encoding key $E_A = (e_A, n_A)$ and a decoding key $D_A = (d_A, n_A)$,
where[in] n_A is a composite number of the form

$$n_A = p_{A,1} \cdot p_{A,2} \cdot \dots \cdot p_{A,k}$$

where

k is an integer greater than 2,

$p_{A,1}, p_{A,2}, \dots, p_{A,k}$ are distinct random prime numbers,

e_A is relatively prime to

$\text{lcm}(p_{A,1}-1, p_{A,2}-1, \dots, p_{A,k}-1)$, and

d_A is selected from the group consisting of [the] a class of numbers equivalent to a multiplicative inverse of

$e_A \pmod{\text{lcm}((p_{A,1}-1), (p_{A,2}-1), \dots, (p_{A,k}-1))}$; and[,]

[and including] a second terminal[, comprising:] of the plurality of terminals having

blocking means for transforming a first message₁[-to-be-transmitted] which is to be transmitted on said communications channel from said second terminal to said first terminal, into one or more transmit message word signals M_B , where each M_B corresponds to a number representative of said first message in the range

$0 \leq M_B \leq n_A - 1$, and

encoding means coupled to said channel and adapted for transforming each transmit message word signal M_B to a ciphertext word signal C_B that [and for transmitting C_B on said channel, where C_B] corresponds to a number representative of an [enciphered] encoded form of said first message [and corresponds to] through a relationship of the form

$[C_B \equiv M_B^{e_A} \pmod{n_A}]$ $C_B \equiv M_B^{e_A} \pmod{n_A}$,

[wherein] said first terminal having [comprises:]

decoding means coupled to said channel and adapted for receiving each of said ciphertext word signals C_B from said channel and, having available to it the k distinct random prime numbers $p_{A,1}, p_{A,2}, \dots, p_{A,k}$,

for transforming each of said ciphertext word signals C_B to a receive message word signal $[M_B] \underline{M_B'}$, and

_____ means for transforming said receive message word signal[s] $[M'] \underline{M_B'}$ to said first message, where $[M'] \underline{M_B'}$ [is] corresponds to a number representative of a [deciphered] decoded form of C_B [and corresponds to] through a relationship of the form

$$[M_B' \equiv C_B^{d_A} \pmod{n_A}] \underline{M_B' \equiv C_B^{d_A} \pmod{n_A}};$$

wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime numbers each smaller than p and q, and the composite number m having the same number of digits as the composite number n;

wherein transforming said receive message word signal M_B' to said first message is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m, it takes fewer computational cycles to perform the transforming of said receive message word signal M_B' if the k distinct random prime numbers are used, relative to the number of computational cycles for performing a transforming of said receive message word signal M_B' if the pair of prime numbers p and q is used instead.

6. (Three times amended) The system according to claim 5 wherein said second terminal is characterized by an [associated] encoding key $E_B = (e_B, n_B)$ and a decoding key $[DB = (D_B, d_B)] \underline{D_B = (d_B, n_B)}$, where[:]

n_B is a composite number of the form

$$n_B = p_{B,1} \cdot p_{B,2} \cdot \dots \cdot p_{B,k_k}$$

where

k is an integer greater than 2,

$p_{B,1}, p_{B,2}, \dots, p_{B,k}$ are distinct random prime numbers,

e_B is relatively prime to

$\text{lcm}(p_{B,1}-1, p_{B,2}-1, \dots, p_{B,k}-1)$, and

d_B is selected from the group consisting of [the] a class of numbers equivalent to a multiplicative inverse of

$$e_B \pmod{(\text{lcm}((p_{B,1}-1), (p_{B,2}-1), \dots, (p_{B,k}-1)))},$$

[wherein] said first terminal [comprises:] further having

blocking means for transforming a second message, [-to-be-transmitted] which is to be transmitted on said communications channel from said first terminal to said second terminal, to one or more transmit message word signals M_A , where each M_A corresponds to a number representative of said message in the range

$$[0 \leq M_A^{e_B} \pmod{n_B}], \underline{0 \leq M_A \leq n_B-1, \text{ and}}$$

encoding means coupled to said channel and adapted for transforming each transmit message word signal M_A to a ciphertext word signal C_A and for transmitting C_A on said channel, [] where C_A corresponds to a number representative of an encoded [enciphered] form of said second message [and corresponds to] through a relationship of the form

$$[C_A \equiv M_A^{e_B} \pmod{n_B}] \underline{C_A \equiv M_A^{e_B} \pmod{n_B}}; \text{ and}$$

[wherein] said second terminal [comprises:] further having

decoding means coupled to said channel and adapted for receiving each of
said ciphertext word signals C_A from said channel and, having available
to it the k distinct random prime numbers $p_{B,1}, p_{B,2}, \dots, p_{B,k}$ for
transforming each of said ciphertext word signals to a receive message
word signal M_A' , and

___ means for transforming said receive message word signals $[M_A]$ M_A' to said
second message, [] where $[M']$ M_A' corresponds to a number
representative of a [deciphered] decoded form of C_A [and corresponds
to] through a relationship of the form

$$[M_A' \equiv C_A^{d_B} \pmod{n_B}] \quad \underline{M_A' \equiv C_A^{d_B} \pmod{n_B}}.$$

7. Cancel claim 7.

8. Cancel claim 8.

9. (Four times amended) A [communication] system for [transferring]
communications of message signals $[M_i]$ cryptographically processed with RSA
public key signing, comprising:

j [stations,] terminals including first and second terminals, each of the j
[stations] terminals being characterized by an encoding key $E_i = (e_i, n_i)$
and decoding key $D_i = (d_i, n_i)$ [], where $i = 1, 2, \dots, j$, [and wherein
 M_i corresponds to a number representative of a message signal to be
transmitted from the i^{th} terminal,] each of the j terminals being adapted to
transmit a particular one of the message signals where an i^{th} message
signal M_i is transmitted from an i^{th} terminal and

$$0 \leq M_i \leq n_i - 1,$$

n_i [is] being a composite number of the form

$$[n_i = p_{i,1} \cdot p_{i,2} \cdot \dots \cdot p_{i,k}] \quad \underline{n_i = p_{i,1} \cdot p_{i,2} \cdot \dots \cdot p_{i,k}}$$

where

k is an integer greater than 2,

$p_{i,1}, p_{i,2}, \dots, p_{i,k}$ are distinct random prime numbers,

e_i is relatively prime to $\text{lcm}(p_{i,1}-1, p_{i,2}-1, \dots, p_{i,k}-1)$, and

d_i is selected from the group consisting of [the] a class of numbers equivalent to a multiplicative inverse of

$$e_i \pmod{(\text{lcm}((p_{i,1}-1), (p_{i,2}-1), \dots, (p_{i,k}-1)))};$$

said [a] first terminal [one of the j terminals] including

means for encoding a digital message word signal $[M_A]$ $\underline{M_1}$ [for transmission] to be transmitted from said first terminal ($i = 1[A]$) to [a] said second terminal [one of the j terminals] ($i = 2[B]$), [and] said encoding means [for] transforming said digital message word signal $[M_A]$ $\underline{M_1}$ to a signed message word signal $[M_{As}]$ $\underline{M_{1s}}$ using a relationship of the form [, M_{As} corresponding to a number representative of an encoded form of said message word signal M_A , whereby:]

$$[M_{As} \equiv M_A^{d_A} \pmod{n_A}] \quad \underline{M_{1s} \equiv M_1^{d_1} \pmod{n_1}}; \text{ and}$$

means for transmitting said signed message word signal M_{1s} from said first terminal to said second terminal, wherein said second terminal includes
means for decoding said signed message word signal M_{1s} to said digital message word signal M_1 ;

wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime number each smaller than p and q, and the composite number m having the same number of digits as the composite number n;

wherein encoding a digital message word signal M_1 is divided into sub-steps, on sub-step for each of the k distinct random prime numbers; and

wherein for a give number of digits for composite numbers n and m, it takes fewer computational cycles to perform the encoding of the digital message word signal M_1 if the k distinct random prime numbers are used, relative to the number of computational cycles for performing an encoding of the digital message word signal M_1 if the pair of prime numbers p and q is used instead.

10. (Three times amended) The system of claim 9, wherein the means for decoding signed message word signal M_{1s} includes means for [further comprising:

means for transmitting said signal message word signal M_{As} from said first terminal to said second terminal, and wherein said second terminal includes means for decoding said signed message word signal M_{As} to said message word signal M_A , said second terminal including:

means for] transforming said signed message word signal $[M_{As}] \underline{M_{1s}}$ to said digital message word signal $[M_A] \underline{M_1}$ [, whereby] using a relationship of the form $[M_A \equiv M_{As}^{e_A} \pmod{n_A}] \underline{M_1 \equiv M_{1s}^{e_1} \pmod{n_1}}$.

11. (Four times amended) A communications system for transferring a message signal $[M]$ cryptographically processed with RSA public key encryption, the communications system comprising:

j communication stations including first and second stations, each of the j communication stations being characterized by an encoding key $E_i = (e_i, n_i)$ and a decoding key $D_i = (d_i, n_i)$, where $i = 1, 2, \dots, j$, [and

wherein M_i corresponds to a number representative of a message signal to be transmitted from the i^{th} terminal,] each of the j communication stations being adapted to transmit a particular one of the message signals where an i^{th} message signal M_i is received from an i^{th} communication station, and

$$0 \leq M_i \leq n_i - 1$$

n_i [is] being a composite number of the form

$$n_i = p_{i,1} \cdot p_{i,2} \cdot \dots \cdot p_{i,k}$$

where

k is an integer greater than 2,

$p_{i,1}, p_{i,2}, \dots, p_{i,k}$ are distinct random prime numbers,

e_i is relatively prime to $\text{lcm}(p_{i,1}-1, p_{i,2}-1, \dots, p_{i,k}-1)$, and

d_i is selected from the group consisting of [the] a class of numbers equivalent to a multiplicative inverse of

$$e_i \pmod{(\text{lcm}((p_{i,1}-1), (p_{i,2}-1), \dots, (p_{i,k}-1)))}$$

[a] said first station [one of the j communication stations] including

means for encoding a digital message word signal $[M_A]$ M_1 [for transmission] to be transmitted from said first station [one of the j communication stations] ($l = 1[A]$) to [a] said second station [one of the j communication stations] ($l = 2[B]$),

means for transforming said digital message word signal $[M_A]$ M_1 to one or more message block word signals $[M_A']$ M_1' , each block word signal $[M_A']$ M_1' being a number representative of a portion of said digital message word signal $[M_A']$ M_1 in the range

$$0 \leq M_1' \leq n_2 - 1, [0 \leq M_A \leq n_B - 1,] \text{ and}$$

means for transforming each of said message block word signals M_1 "
[M_A "] to a ciphertext word signal C_1 using a relationship of the form
[C_A , C_A corresponding to a number representative of an encoded
form of said message block word signal M_A ", whereby:]

$$[C_A \equiv M_A^{E_b} \pmod{n_B}] \quad \underline{C_1 \equiv M_1^{e_2} \pmod{n_2}}; \text{ and}$$

means for transmitting said ciphertext signals C_1 from said first station to
said second station, wherein said second station includes

means for deciphering said ciphertext signals C_1 using $p_{2,1}$, $p_{2,2}$, . . .
 $p_{2,k}$ to produce said digital message word signal M_1 ;

wherein p and q are a pair of prime numbers that product of which equals a
composite number m , the k distinct random prime numbers each smaller
than p and q , and the composite number m having the same number of
digits as the composite number n ;

wherein deciphering said ciphertext signals C_1 is divided into sub-steps, one
sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m , it takes
fewer computational cycles to perform the deciphering of said ciphertext
signals C_1 if the k distinct random prime numbers are used, relative to the
number of computational cycles for performing a deciphering of said
ciphertext signals C_1 if the pair of prime numbers p and q is used instead.

12. (Three times amended) The communications system of claim 11, [further
comprising:

means for transmitting said ciphertext word signals from said first terminal to
said second terminal, and] wherein [said second terminal] the
deciphering means includes

means for decoding said ciphertext word signals C_1 to said message block
word signals $[M_A]$ M_1 " using a relationship of the form[, said second
terminal including:

means for transforming each of said ciphertext word signals C_A to one of
said message block word signals M_A ", whereby

$$M_A" \equiv C_A^{D_b} (\text{mod } n_B)]$$

$$\underline{M_1" \equiv C_1^{d_2} (\text{mod } n_2)}, \text{ and}$$

means for transforming said message block word signals $[M_A"]$ M_1 " to said
message word signal $[M_A]$ M_1 .

13. Cancel claim 13.

14. (Three times amended) A method of communicating a message
cryptographically processed with an RSA public key encryption, comprising the
steps of:

selecting a public key portion e associated with a recipient intended for
receiving the message;

developing k distinct random prime numbers, p_1, p_2, \dots, p_k , where $k \geq 3$, and

checking that each of the k distinct random prime numbers minus 1, $p_1 -$
 $1, p_2 - 1, \dots, p_k - 1$, is relatively prime to the public key portion e;

computing a composite number, n, as a product of the k distinct random
prime numbers;

receiving a ciphertext message formed by encoding a plaintext message
data M to the ciphertext message data C using a relationship of the form

$$\underline{C \equiv M^e (\text{mod } n)}$$

where M represents the message, where $0 \leq M \leq n-1$, and where the sender knows n and the public key portion e but has no access to the k distinct random prime numbers, p_1, p_2, \dots, p_k ; and
deciphering at the recipient the received ciphertext message data C to produce the message, the recipient having access to the k distinct random prime numbers, p_1, p_2, \dots, p_k ;
wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime numbers each smaller than p and q, and the composite number m having the same number of digits as the composite number n;
wherein the deciphering step is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and
wherein for a given number of digits for composite numbers n and m, it takes fewer computational cycles to perform the deciphering step if the k distinct random prime numbers are used, relative to the number of computational cycles for performing a deciphering step if the pair of prime numbers p and q is used instead.

15. (Amended) The method according to claim 14, comprising the further step of:

establishing a private key portion d by a relationship to the public key portion e in the form of $d \equiv e^{-1}(\text{mod}((p_1-1) \cdot (p_2-1) \cdot \dots \cdot (p_k-1)))$,
wherein the deciphering step includes decoding the ciphertext message data C to the plaintext message data M using a relationship of the form
 $M \equiv C^d (\text{mod } n)$.

16. (Three times amended) A method of communicating a message cryptographically processed with RSA public key encryption, comprising the steps of:

selecting a public key portion e;

developing k distinct random prime numbers p_1, p_2, \dots, p_k , where $k \geq 3$, and
checking that each of the k distinct random prime numbers minus 1, $p_1 - 1, p_2 - 1, \dots, p_k - 1$, is relatively prime to the public key portion e;
establishing a private key portion d by a relationship to the public key portion
e in the form of $d \equiv e^{-1}(\text{mod}((p_1 - 1) \cdot (p_2 - 1) \cdots (p_k - 1)))$;
computing a composite number, n, as a product of the k distinct random
prime numbers;
receiving a ciphertext message data C representing an encoded form of a
plaintext message data M; and
decoding the received ciphertext message data C to the plaintext message
data M using a relationship of the form

$$M \equiv C^d (\text{mod } n),$$

the decoding performed by a recipient owning the private key portion d
and having access to the k distinct random prime numbers p_1, p_2, \dots, p_k ;
wherein p and q are a pair of prime numbers that product of which equals a
composite number m, the k distinct random prime numbers each smaller
than p and q, and the composite number m having the same number of
digits as the composite number n;
wherein the decoding step is divided into sub-steps, one sub-step for each of
the k distinct random prime numbers; and
wherein for a given number of digits for composite numbers n and m, it takes
fewer computational cycles to perform the decoding step if the k distinct
random prime numbers are used, relative to the number of computational
cycles for performing a decoding step if the pair of prime numbers p and
q is used instead.

17. (Amended) The method according to claim 16, wherein the ciphertext
message data C is formed by encoding the plaintext message data M to the
ciphertext message data C using a relationship of the form $C \equiv M^e (\text{mod } n)$.

wherein $0 \leq M \leq n-1$ and wherein n and the public key portion e are accessible to the sender although it has no access to the k distinct random prime numbers p_1, p_2, \dots, p_k .

18. (Three times amended) A method of communicating a message cryptographically processed with RSA public key signing, comprising the steps of:

selecting a public key portion e ;

developing k distinct random prime numbers p_1, p_2, \dots, p_k , where $k \geq 3$, and

checking that each of the k distinct random prime numbers minus 1, $p_1-1, p_2-1, \dots, p_k-1$, is relatively prime to the public key portion e ;

establishing a private key portion d by a relationship to the public key portion e of the form $d \equiv e^{-1} \pmod{(p_1-1) \cdot (p_2-1) \cdots (p_k-1)}$;

computing a composite number, n , as a product of the k distinct random prime numbers;

encoding a plaintext message data M with the private key portion d to produce a signed message M_s using a relationship of the form

$$M_s \equiv M^d \pmod{n},$$

where $0 \leq M \leq n-1$;

receiving the signed message M_s ; and

deciphering the signed message to produce the plaintext message data M ;

wherein p and q are a pair of prime numbers that product of which equals a composite number m , the k distinct random prime numbers each smaller than p and q , and the composite number m having the same number of digits as the composite number n ;

wherein the encoding step is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m , it takes fewer computational cycles to perform the encoding step if the k distinct

random prime numbers are used, relative to the number of computational cycles for performing an encoding step if the pair of prime numbers p and q is used instead.

19. (Amended) The method of claim 18, wherein the deciphering step includes:

decoding the signed message M_s with the public key portion e to produce the plaintext message data M using a relationship of the form $M \equiv M_s^e \pmod{n}$.

20. (Three times amended) A method for communicating a message cryptographically processed with RSA public key encryption, comprising the steps of:

sending to a recipient a cryptographically processed message formed by assigning a number M to represent the message in plaintext message form, and cryptographically transforming the assigned number M from the plaintext message form to a number C that represents the message in an encoded form, wherein the number C is a function of

the assigned number M,

a number n that is a composite number equaling the product of at least three distinct random prime numbers, wherein $0 \leq M \leq n-1$,

and

an exponent e that is a number relatively prime to a lowest common multiplier of the at least three distinct random prime numbers,

wherein the number n and exponent e having been obtained by the sender are associated with the recipient to which the message is intended; and

receiving the cryptographically processed message which is decipherable by the recipient based on

the number n,

another exponent d, and

the number C,
wherein the exponent d is a function of the exponent e and the at least
three distinct random prime numbers;
wherein p and q are a pair of prime numbers that product of which equals a
composite number m, the at least three distinct random prime numbers
each smaller than p and q, and the composite number m having the
same number of digits as the composite number n;
wherein deciphering the cryptographically processed message is divided into
sub-steps, one sub-step for each of the at least three distinct random
prime numbers; and
wherein for a given number of digits for composite numbers n and m, it takes
fewer computational cycles to perform the deciphering if the at least three
distinct random prime numbers are used, relative to the number of
computational cycles for performing a deciphering if the pair of prime
numbers p and q is used instead.

21. (Amended) The method according to claim 20,
wherein the cryptographically transforming step includes using a relationship
of the form $C \equiv M^e \pmod{n}$,
wherein the exponent d is established based on the at least three distinct
random prime numbers p_1, p_2, \dots, p_k , using a relationship of the form
 $d \equiv e^{-1} \pmod{((p_1-1) \cdot (p_2-1) \cdots (p_k-1))}$, and
wherein the cryptographically processed message is deciphered using a
relationship of the form $M \equiv C^d \pmod{n}$.

22. (Three times amended) A method for communicating a message
cryptographically processed with RSA public key encryption, comprising the
steps of:

receiving from a sender a cryptographically processed message, in the form
of a number C, which is decipherable by the recipient based on a number
n, an exponent d, and the number C; and

deciphering the cryptographically processed message,
wherein a number M represents a plaintext form of the message,
wherein the number C represents a cryptographically encoded form of
the message and is a function of
the number M,
the number n that is a composite number equaling the product of
at least three distinct random prime numbers, wherein
 $0 \leq M \leq n-1$, and
an exponent e that is a number relatively prime to a lowest
common multiplier of the at least three distinct random prime
numbers,
wherein the number n and exponent e are associated with the recipient to
which the message is intended, and
wherein the exponent d is a function of the exponent e and the at least
three distinct random prime numbers;
wherein p and q are a pair of prime numbers that product of which equals a
composite number m, the at least three distinct random prime numbers
each smaller than p and q, and the composite number m having the
same number of digits as the composite number n;
wherein deciphering the cryptographically processed message is divided into
sub-steps, one sub-step for each of the at least three distinct random
prime numbers; and
wherein for a given number of digits for composite numbers n and m, it takes
fewer computational cycles to perform the deciphering if the at least three
distinct random prime numbers are used, relative to the number of
computational cycles for performing a deciphering if the pair of prime
numbers p and q is used instead.

23. (Amended) The method according to claim 22,

wherein the number C is formed using a relationship of the form
 $C \equiv M^e \pmod{n}$,

wherein the exponent d is established based on the at least three distinct random prime numbers p_1, p_2, \dots, p_k , using a relationship of the form $d \equiv e^{-1}((p_1-1) \cdot (p_2-1) \cdots (p_k-1))$,

and wherein the number M is obtained using a relationship of the form $M \equiv C^d \pmod{n}$.

24. Cancel claim 24.

25. Cancel claim 25.

26. Cancel claim 26.

27. Cancel claim 27.

28. Cancel claim 28.

29. Cancel claim 29.

30. Cancel claim 30.

31. Cancel claim 31.

32. Cancel claim 32.

33. Cancel claim 33.

34. (Twice amended) The method according to claim 14, wherein a message cryptographically processed by the sender with two-prime RSA public key encryption characterized by the composite number m being computed as the product of the pair of prime numbers p and q , is decipherable with multi-prime ($k > 2$) RSA public key encryption characterized by the composite number

n being computed as the product of the k distinct random prime numbers p_1, p_2, \dots, p_k .

35. (Three times amended) The method according to claim 9, wherein the signed message word signal M_{1s} , formed from the digital message word signal M_1 being cryptographically processed at the first terminal with multi-prime ($k > 2$) RSA public key signing which is characterized by the composite number n being computed as the product of the k distinct random prime numbers p_1, p_2, \dots, p_k , is decipherable at the second terminal with two-prime RSA public key signing characterized by the composite number m being computed as the product of the pair of prime numbers p and q.

36. (Twice amended) The method according to claim 16, wherein a message cryptographically processed by the sender with two-prime RSA public key encryption characterized by the composite number m being computed as the product of the pair of prime numbers p and q, is decipherable by the decoding with multi-prime ($k > 2$) RSA public key encryption characterized by the composite number n being computed as the product of the k distinct random prime numbers p_1, p_2, \dots, p_k .

37. (Twice amended) The method according to claim 18, wherein the signed message M_s formed from the plaintext message data M being cryptographically processed at the sender with multi-prime ($k > 2$) RSA public key signing which is characterized by the composite number n being computed as the product of the k distinct random prime numbers p_1, p_2, \dots, p_k , is decipherable by the decoding at the recipient with two-prime RSA public key signing characterized by the composite number m being computed as the product of the pair of prime numbers p and q.

38. (Twice amended) The method according to claim 20, wherein a message cryptographically processed by the sender with two-prime RSA public

key encryption characterized by the composite number m being computed as the product of the pair of prime numbers p and q, is decipherable at the recipient with multi-prime RSA public key encryption characterized by the composite number n being computed as the product of the at least three distinct random prime numbers.

39. (Twice amended) The method according to claim 22, wherein a message cryptographically processed by the sender with two-prime RSA public key encryption characterized by the composite number m being computed as the product of the pair of prime numbers p and q, is decipherable at the recipient with multi-prime RSA public key encryption characterized by the composite number n being computed as the product of the at least three distinct random prime numbers.

40. (Three times amended) A cryptography method for local storage of data by a private key owner, comprising the steps of:

selecting a public key portion e;

developing k distinct random prime numbers p_1, p_2, \dots, p_k , where $k \geq 3$, and checking that each of the k distinct random prime numbers minus 1, $p_1-1, p_2-1, \dots, p_k-1$, is relatively prime to the public key portion e;

establishing a private key portion d by a relationship to the public key portion e in the form of $d \equiv e^{-1}(\text{mod}((p_1-1) \cdot (p_2-1) \cdots (p_k-1)))$;

computing a composite number, n, as a product of the k distinct random prime numbers that are factors of n, where only the private key owner knows the factors of n; and

encoding plaintext data M to ciphertext data C for the local storage, using a relationship of the form

$$C \equiv M^e \pmod{n},$$

wherein $0 \leq M \leq n-1$, whereby the ciphertext data C is decipherable only by the private key owner having available to it the factors of n;
wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime numbers each smaller than p and q, and the composite number m having the same number of digits as the composite number n;
wherein the encoding step is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and
wherein for a given number of digits for composite numbers n and m, it takes fewer computational cycles to perform the encoding step if the k distinct random prime numbers are used, relative to the number of computational cycles for performing an encoding step if the pair of prime numbers p and q is used instead.

41. The cryptography method in accordance with claim 40, further comprising the step of:

decoding the ciphertext data C from the local storage to the plaintext data M using a relationship of the form $M \equiv C^d \pmod{n}$.

42. (Three times amended) A cryptographic communications system, comprising:

a plurality of stations;

a communications medium; and

a host system adapted to communicate with the plurality of stations via the communications medium sending and receiving messages cryptographically processed with an RSA public key encryption, the host system including at least one cryptosystem configured for developing k distinct random prime numbers p_1, p_2, \dots, p_k , where $k \geq 3$,

checking that each of the k distinct random prime numbers minus 1, $p_1-1, p_2-1, \dots, p_k-1$, is relatively prime to a public key portion e that is associated with the host system,

computing a composite number, n, as a product of the k distinct random prime numbers,

establishing a private key portion d by a relationship of the public key portion e in the form of $d \equiv e^{-1}(\text{mod}((p_1-1) \cdot (p_2-1) \cdots (p_k-1)))$,

in response to an encoding request from the host system, encoding a plaintext message data M producing therefrom a ciphertext message data C to be communicated via the host system, the encoding using a relationship of the form

$$C \equiv M^e \pmod{n},$$

where $0 \leq M \leq n-1$, and

in response to a decoding request from the host system, decoding a ciphertext message data C' communicated via the host producing therefrom a plaintext message data M' using a relationship of the form

$$M' \equiv C'^d \pmod{n};$$

wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime numbers each smaller than p and q, and the composite number m having the same number of digits as the composite number n;

wherein decoding the ciphertext message data C' is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m, it takes fewer computational cycles to perform the decoding of the ciphertext message data C' if the k distinct random prime numbers are used,

relative to the number of computational cycles for performing a decoding of the ciphertext message data C' if the pair of prime numbers p and q is used instead.

43. (Three times amended) A system for communications of a message cryptographically processed with RSA public key encryption, comprising:

a bus; and

a cryptosystem communicatively coupled to and receiving from the bus encoding and decoding requests, the cryptosystem being configured for

providing a public key portion e,

developing k distinct random prime numbers p_1, p_2, \dots, p_k , where $k \geq 3$,

checking that each of the k distinct random prime numbers minus 1,

$p_1-1, p_2-1, \dots, p_k-1$, is relatively prime to the public key portion e,

computing a composite number, n, as a product of the k distinct random prime numbers,

establishing a private key portion d by a relationship to the public key portion e in the form of $d \equiv e^{-1}(\text{mod}((p_1-1) \cdot (p_2-1) \cdots (p_k-1)))$,

in response to an encoding request from the bus, encoding a plaintext form of a first message M to produce C, a ciphertext form of the first message, using a relationship of the form

$$C \equiv M^e \pmod{n},$$

where $0 \leq M \leq n-1$, and

in response to a decoding request from the host system, decoding C', a ciphertext form of a second message, to produce M', a plaintext form of the second message, using a relationship of the form

$$M' \equiv C'^d \pmod{n},$$

the first and second messages being distinct or one and the same;
wherein p and q are a pair of prime numbers that product of which equals a
composite number m, the k distinct random prime numbers each smaller
than p and q, and the composite number m having the same number of
digits as the composite number n;
wherein decoding C' is divided into sub-steps, one sub-step for each of the k
distinct random prime numbers; and
wherein for a given number of digits for composite numbers n and m, it takes
fewer computational cycles to perform the decoding of C' if the k distinct
random prime numbers are used, relative to the number of computational
cycles for performing a decoding of C' if the pair of prime numbers p and
q is used instead.

44. The system of claim 42, wherein the at least one cryptosystem includes
a plurality of exponentiators configured to operate in parallel in developing
respective subtask values corresponding to the message.

45. (Twice amended) The system of claim 42, wherein the at least one
cryptosystem includes

a processor,

a data-address bus,

a memory coupled to the processor via the data-address bus,

a data encryption standard (DES) unit coupled to the memory and the
processor via the data-address bus, and

a plurality of exponentiator elements coupled to the processor via the DES
unit, the plurality of exponentiator elements being configured to operate
in parallel in developing respective subtask values corresponding to the
message.

46. (Amended) The system of claim 45, wherein the memory and each of
the plurality of exponentiator elements has its own DES unit that

cryptographically processes message data received/returned from/to the processor.

47. (Amended) The system of claim 45, wherein the memory is partitioned into address spaces addressable by the processor, including secure, insecure and exponentiator elements address spaces, and wherein the DES unit is configured to recognize the secure and exponentiator elements address spaces and to automatically encode message data therefrom before it is provided to the exponentiator elements, the DES unit being bypassed when the processor is accessing the insecure memory address spaces, the DES unit being further configured to decode encoded message data received from the memory before it is provided to the processor.

48. The system of claim 45, wherein the at least one cryptosystem meets FIPS (Federal Information Processing Standard) 140-1 level 3.

49. (Amended) The system of claim 45, wherein the processor maintains in the memory the public key portion e and the composite number n with its factors p_1, p_2, \dots, p_k .

50. (Three times amended) A system for communications of a message cryptographically processed with RSA public key encryption, comprising:

a bus; and

a cryptosystem receiving from the system via the bus encoding and decoding requests, the cryptosystem including

a plurality of exponentiator elements configured to develop subtask values,

a memory, and

a processor configured for

receiving the encoding and decoding requests, each encoding request providing a plaintext message M to be encoded,

obtaining a public key that includes an exponent e and a modulus n , a representation of the modulus n existing in the memory in the form of its k distinct random prime number factors p_1, p_2, \dots, p_k , where $k \geq 3$,
constructing subtasks, one subtask for each of the k factors, to be executed by the exponentiator elements for producing respective ones of the subtask values C_1, C_2, \dots, C_k , and
forming a ciphertext message C from the subtask values C_1, C_2, \dots, C_k ,
wherein the ciphertext message C is decipherable using a private key that includes the modulus n and an exponent d which is a function of e ;

wherein p and q are a pair of prime numbers that product of which equals a modulus m , the k distinct random prime numbers each smaller than p and q , and the modulus m having the same number of digits as the modulus n ; and

wherein for a given number of digits for modulus n and modulus m , it takes fewer computational cycles to form the ciphertext message C if the k distinct random prime numbers are used, relative to the number of computational cycles for forming a ciphertext message C' if the pair of prime numbers p and q is used instead.

51. (Twice amended) The system of claim 50, wherein each one of the subtask values C_1, C_2, \dots, C_k is developed using a relationship of the form $C_i \equiv M_i^{e_i} \pmod{p_i}$, where $M_i \equiv M \pmod{p_i}$, and $e_i \equiv e \pmod{p_i-1}$, and where $i = 1, 2, \dots, k$.

52. (Three times amended) A system for communications of a message cryptographically processed with RSA public key encryption, comprising:
a bus; and

a cryptosystem receiving from the system via the bus encoding and decoding requests, the cryptosystem including
a plurality of exponentiator elements configured to develop subtask values,
a memory, and
a processor configured for
receiving the encoding and decoding requests, each
encoding/decoding request provided with a plaintext/ciphertext message M/C to be encoded/decoded and with or without a
public/private key that includes an exponent e/d and a modulus n representation of which exists in the memory in the form of its
k distinct random prime number p_1, p_2, \dots, p_k , where $k \geq 3$,
obtaining the public/private key from the memory if the
encoding/decoding request is provided without the
public/private key,
constructing subtasks to be executed by the exponentiator
elements for producing respective ones of the subtask values
 $M_1, M_2, \dots, M_k/C_1, C_2, \dots, C_k$, and
forming the ciphertext/plaintext message C/M from the subtask
values $C_1, C_2, \dots, C_k/M_1, M_2, \dots, M_k$;
wherein p and q are a pair of prime numbers that product of which equals a
modulus m, the k distinct random prime numbers each smaller than p
and q, and the modulus m having the same number of digits as the
modulus n; and
wherein for a given number of digits for modulus n and modulus m, it takes
fewer computational cycles to form the ciphertext/plaintext message C/M
if the k distinct random prime numbers are used, relative to the number of
computational cycles for forming a ciphertext/plaintext message C'/M' if
the pair of prime numbers p and q is used instead.

53. (Amended) The system of claim 52 wherein when produced each one of the subtasks C_1, C_2, \dots, C_k is developed using a relationship of the form $C_i \equiv M_i^{e_i} \pmod{p_i}$, where $C_i \equiv C \pmod{p_i}$, and $e_i = e \pmod{p_i-1}$, and where $i = 1, 2, \dots, k$.

54. (Amended) The system of claim 52 wherein when produced each one of the subtasks M_1, M_2, \dots, M_k is developed using a relationship of the form $M_i \equiv C_i^{d_i} \pmod{p_i}$, where $M_i \equiv M \pmod{p_i}$, and $d_i = d \pmod{p_i-1}$, and where $i = 1, 2, \dots, k$.

55. The system of claim 54, wherein the private key exponent d relates to the public key exponent e via $d \equiv e^{-1} \pmod{(p_1-1) \cdot (p_2-1) \cdots (p_k-1)}$.

56. (Three times amended) A system for communications of a message cryptographically processed with RSA public key encryption, comprising:

means for selecting a public key portion e ;

means for developing k distinct random prime number p_1, p_2, \dots, p_k , where $k \geq 3$, and for checking that each of the k distinct random prime numbers minus 1, $p_1-1, p_2-1, \dots, p_k-1$, is relatively prime to the public key portion e ;

means for establishing a private key portion of d by a relationship to the public key portion e in the form of $d \equiv e^{-1} \pmod{(p_1-1) \cdot (p_2-1) \cdots (p_k-1)}$;

means for computing a composite number, n , as a product of the k distinct random prime numbers;

means for receiving a ciphertext message data C ; and

means for decoding the ciphertext message data C to a plaintext message data M using a relationship of the form

$$M \equiv C^d \pmod{n};$$

wherein p and q are a pair of prime numbers that product of which equals a composite number m, the k distinct random prime numbers each smaller than p and q, and the composite number m having the same number of digits as the composite number n;

wherein decoding said ciphertext message data C is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m, it takes fewer computational cycles to perform the decoding of said ciphertext message data C if the k distinct random prime numbers are used, relative to the number of computational cycles for performing a decoding of said ciphertext message data C if the pair of prime numbers p and q is used instead.

57. The system according to claim 56, further comprising:

means for encoding the plaintext message data M to the ciphertext message data C, using a relationship of the form $C \equiv M^e \pmod{n}$, where $0 \leq M \leq n-1$.

58. (Three times amended) A system for communications of a message cryptographically processed with RSA public key signing, comprising:

means for selecting a public key portion e;

means for developing k distinct random prime numbers p_1, p_2, \dots, p_k , where $k \geq 3$, and for checking that each of the k distinct random prime numbers minus 1, $p_1-1, p_2-1, \dots, p_k-1$, is relatively prime to the public key portion e;

means for establishing a private key portion d by a relationship to the public key portion e of the form $d \equiv e^{-1} \pmod{(p_1-1) \cdot (p_2-1) \cdots (p_k-1)}$;

means for computing a composite number, n, as a product of the k distinct random prime numbers; and

means for encoding a plaintext message data M with the private key portion d to produce a signed message M_s , using a relationship of the form

$$M_s \equiv M^d \pmod{n},$$

where $0 \leq M \leq n-1$, the signed message M_s being decipherable using the public key portion e ;

wherein p and q are a pair of prime numbers that product of which equals a composite number m , the k distinct random prime numbers each smaller than p and q , and the composite number m having the same number of digits as the composite number n ;

wherein encoding said plaintext message data M is divided into sub-steps, one sub-step for each of the k distinct random prime numbers; and

wherein for a given number of digits for composite numbers n and m , it takes fewer computational cycles to perform the encoding of said plaintext message data M if the k distinct random prime numbers are used, relative to the number of computational cycles for performing an encoding of said plaintext message data M if the pair of prime numbers p and q is used instead.

59. (Twice amended) The system of claim 58 further comprising:

means for decoding the signed message M_s with the public key portion e to produce the plaintext message data M using a relationship of the form

$$M \equiv M_s^e \pmod{n}.$$

60. (Amended) The system of claim 57, wherein the system can communicate the cryptographically processed message to another system that encodes/decodes data with RSA public key encryption using a modulus value equal to n independent of the k distinct prime numbers.

61. (Amended) The system of claim 59, wherein the system can communicate the cryptographically processed message to another system that

encodes/decodes data with RSA public key signing using a modulus value equal to n independent of the k distinct prime numbers.

62. The method according to claim 14, wherein n and m include values that are more than 600 digits long.

63. The method according to claim 16, wherein n and m include values that are more than 600 digits long.

64. The method according to claim 18, wherein n and m include values that are more than 600 digits long.

65. The method according to claim 20, wherein n and m include values that are more than 600 digits long.

66. The method according to claim 22, wherein n and m include values that are more than 600 digits long.